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[COMMUNICATION]

Maternal Behavior in Virgin Female Rats Following Removal of the Vomeronasal Organ

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ABSTRACT—Induction of the maternal behavior in virgin female rats exposed continuously to young foster pups was studied. The vomeronasal organ (VNO) ablation accelerated the onset of maternal behavior of virgin females following continuous exposure to foster pups. It may be possible that the neural substrates of the VNO play an inhibitory role in expressing the maternal behavior in virgin female rats.

INTRODUCTION

The vomeronasal organ (VNO) in most mammalian species consists of a bilaterally paired tubular structure lying on either side at the base of the nasal septum. Peripheral receptor neurons within the VNO innervate the accessory olfactory bulbs (AOB) and are anatomically independent of the olfactory receptor neurons within the olfactory epithelium, which project to the main olfactory bulbs (MOB). In turn, the AOB and MOB give rise to separate afferent pathways which terminate in different areas of the pyriform lobe and amygdala (AMYG). From the AMYG, vomeronasal pathways project to the medial preoptic area (MPOA) and the ventromedial nucleus of the hypothalamus (VMH) [1].

Functionally, the VNO conveys chemosensory informations to its parts of the hypothalamus thought to be important in the regulation of reproductive physiology and behavioral functions. Saito and Moltz [2, 3], for example, showed that ablation of the VNO reduced the incidence of sexual behavior in rats and Saito [4] suggested that the vomeronasal inputs from pups facilitated the maternal behavior of lactating rats.

It is well known that maternal behavior in the lactating rat is observed within a few hours of parturition. The virgin rat, however, does not show immediate maternal responsiveness toward foster pups. If virgin rats are exposed continuously to young foster pups, they begin to show maternal behavior within 10 days [5]. The purpose of the present experiment was to determine the role of the vomeronasal system in maternal behavior of virgin female rats.

MATERIALS AND METHODS

Subject: Eighteen virgin female Wistar rats (250–300 g) were used in this experiment. The animals were kept in the room of a temperature of 23–25°C and exposed to a light-schedule of 12 hr light and 12 hr darkness (light on at 0600). They received standard laboratory diet and tap water *ad libitum*.

Upon reaching 100–150 days of age, these females underwent either the removal of the VNO (VOX, n=9) or a sham surgical procedure (SHAM, n=9), as detailed by Saito and Moltz [2, 3] and Saito and Mennella [6]. After the operation, each female was housed individually in a wire mesh cage (50×50×40 cm) faced with Plexiglas. Shredded paper was supplied as nest material.

Procedure: Two weeks after the operation, 6

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foster pups of the same strain, 1 to 2 days old, were placed in the quadrant of the cage diagonally opposite to the nest area. Each day, pups were left with the female for a 24-hr period, after which they were removed and then replaced by different fresh pups. After introducing pups, the institution of maternal behavior of the female was observed for 1 hr every day. To be scored as maternal, a female was required not only to retrieve all the 6 pups, but to build a nest, assume a nursing posture, lick the young, and keep them warm. Observations were conducted for 8 days.

Histology: At the end of the examination, each female was sacrificed for histological observations. The animal was perfused with 10% formalin and the head was decalcified in a formic acid solution, embedded in paraffin, sectioned at 40 μm and stained with hematoxylin and eosin.

Statistical analysis: Data were analyzed with Fisher's exact probability test and Mann-Whitney U test for independent samples.

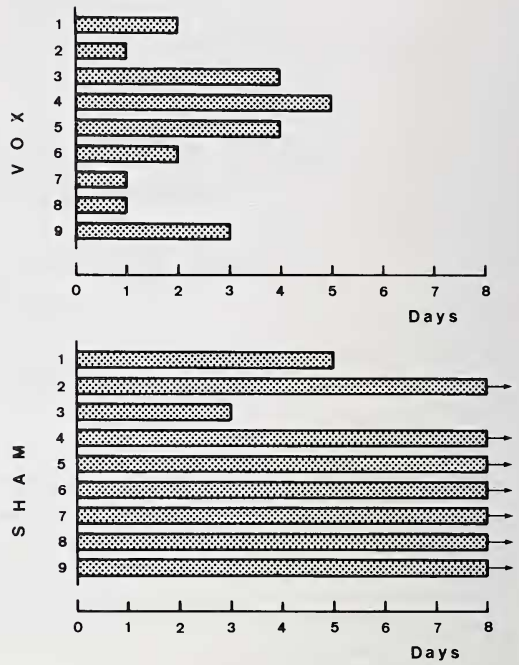

Fig. 1. Latency in time of onset for the display of maternal behavior in the vomeronasal organ-ablated (VOX) and sham-operated (SHAM) virgin female rats. Arrow indicates that the animal failed to act maternally at the conclusion of the observation period.

RESULTS AND DISCUSSION

Figure 1 shows that effects of the vomeronasal organ ablation on the induction of maternal behavior. Of the 9 VOX females, all showed the maternal behavior, while only 2 of 9 females in SHAM group did within 5 days after exposure of pups ($P<0.001$). The remaining 7 females in SHAM group did not show the maternal behavior during an 8-day observation period. The average latency for the onset of maternal behavior in VOX group was 2.6 days (range: 1–5 days). There was a significant difference in the latency between VOX and SHAM groups ($P<0.001$).

Histological examinations confirmed that the removal of the VNO was complete in all of VOX females whereas the VNO was intact in all SHAM females.

These results are somewhat contrasted to that in the lactating rats [4]. In lactating females removal of the VNO severely depressed retrieval, one of maternal behaviors. Numan [7] showed that the MPOA was essential for all components of maternal behavior in the rat. Since the VNO is located in the nasal septum and has fiber connections with the AOB which gives projections to the AMYG and the MPOA [1], the vomeronasal cues emanating from pups may reach the MPOA and depress the outputs of the MPOA, in this way inhibiting maternal behavior. In case of the lactating rats, the hormonal changes which occur around the time of parturition on the MPOA may act on the VNO to reduce this inhibitory influence and/or to play a facilitatory role in displaying maternal behavior. Further study is needed to clarify these points.

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